Department of Water Resources
California Irrigation Management Information System
Irrigation Scheduling

Overview

Good irrigation management is required for efficient and profitable use of water for irrigating agricultural crops and turfgrass. A major part of any irrigation management program is the decision-making process for determining irrigation dates and/or how much water should be applied to the field for each irrigation. This decision-making process is referred to as **irrigation scheduling**

The following is a short description of the water budget method of irrigation scheduling, and how to use CIMIS ETo to help determine irrigation schedules.

Water Budget Method

The water budget method is simply an accounting procedure similar to the bookkeeping required to balance a checking account. If the balance on a given date and the amounts of transactions are known, the balance can be calculated at any time. In addition, the time when all funds would be withdrawn can be determined so that an overdraft is avoided.

For irrigation scheduling, soil water content is balanced. The amount of water that is lost as crop evapotranspiration (ETc) is analogous to writing checks. The water that enters the soil reservoir (as rain or irrigation) is analogous to depositing funds in a checking account. By keeping records of these transactions, it is possible to know how much water is in the soil reservoir at anytime.

The initial balance can be determined by direct observation or assessed after a thorough wetting of the soil by irrigation or winter rains. Daily quantities of ET are depleted until the soil water has been reduced to a desired level. At that point an irrigation should be applied with a net amount equivalent to the accumulated ET losses since the last irrigation. The soil profile is thus recharged to full capacity, and the cycle begins again. If full recharge is not desired or not possible, the new balance can be determined from the net irrigation amount or by field observations. This method, however, may not work well at locations where contributions to crop ET from a water table or other source cannot be quantified.

Field capacity (FC) is the quantity of water stored in a soil volume after drainage of gravitational water. Only a portion of the water content can be potentially removed from a volume of soil by a crop and this quantity is called "available water" (AW). The amount of available water within the crop root zone at any given time is often called "soil moisture reservoir". Unfortunately, only a fraction of the reservoir is readily available to the crop without water stress.

A major goal in good irrigation management is to prevent yield reducing crop water stress by maintaining the soil water content above a certain level. This is done by keeping track of soil water content and knowing how dry the soil can get before yield reducing crop stress will occur (referred to as the yield threshold depletion or YTD). The value of the YTD is mainly dependent upon the crop sensitivity to stress and root density. The ultimate choice of how much water to deplete before an irrigation is made by the irrigation manager depend on cultural practices, labor, water deliveries or other considerations. Irrigation is timed depending on a management allowable depletion (MAD), which is the percent of available water which the irrigator will allow plants to deplete before

irrigating or the depth of water that the irrigator will allow plants to extract from the root zone between irrigations. Generally, the MAD is selected to be less than or equal to the YTD. Another term commonly used in the water budget method is soil moisture depletion (SMD). SMD is the amount of water required at any time to fill the root zone to field capacity.

Crop water use can be calculated with reference evapotranspiration (ETo) from CIMIS and a crop coefficient (Kc) as ETc = ETo x Kc. These ETc estimates can be used to determine day by day soil water depletions from field capacity and thus can be used to schedule irrigations. Table 1 is a sample of how a water budget would be calculated for a seed alfalfa field with the following properties:

Available water (AW)in root zone = 5.0 inches
Management allowable depletion (MAD)= 50%AW = 2.5 inches
Yield threshold depletion (YTD) = 2.6 inches.

TABLE 1. Water budget scheduling example for seed alfalfa.

Date	Effective Rainfall (in)	Irrigation (in)	Crop ET (in)	Depletion (in)	Before MAD (in)
July 1	0.00	0.00	0.00	0.00	2.50
July 2	0.00	0.00	0.30	0.30	2.20
July 3	0.00	0.00	0.19	0.49	2.01
July 4	0.00	0.00	0.22	0.71	1.79
July 5	0.00	0.00	0.28	0.99	1.51
July 6	0.00	0.00	0.25	1.24	1.26
July 7	0.00	0.00	0.26	1.50	1.00
July 8	0.00	0.00	0.28	1.78	0.72
July 9	0.00	0.00	0.32	2.10	0.40
July 10	0.00	0.00	0.36	2.46	0.04
July 11	0.00	2.50	0.40	0.36	2.14
July 12	0.00	0.00	0.22	0.58	1.92
July 13	0.42	0.00	0.11	0.27	2.23
July 14	0.25	0.00	0.15	0.17	2.33
July 15	0.00	0.00	0.25	0.42	2.08

The budget record begins on July 1 with the total water content at field capacity or 2.5 inches MAD. On each day, ETc is added to the depletion on the previous day to obtain a new depletion value. A net of 2.50 inches was applied on July 11 because the depletion from field capacity was going to exceed both MAD and YTD. Effective rainfall, or amount of rainfall that contributes to the soil

reservoir on July 13 and 14 was recorded and the depletion was adjust accordingly.

Irrigation System Efficiency

The water budget method of irrigation scheduling can be used to determine when an irrigation should occur and how much water to replenish. It does not by itself determine how much water should be applied through the irrigation system or how long the irrigation system should be operated to apply the water. Determining the amount of water to actually apply through the irrigation system is done by dividing the amount of water required to replenish the soil reservoir by the efficiency of the irrigation system. Water that runs off the field or percolates below the root zone due to nonuniformity of the irrigation system does not contribute to the soil reservoir. For example, if 30 percent of the water applied runs off the field or percolate below the root zone, the irrigation efficiency is 70 percent and the required applied water for the July 11 irrigation would be:

2.50 inches / 0.70 = 3.57 inches

Therefore, the grower should apply a depth of approximately 3.6 inches to replenish the soil reservoir over the entire field. Any application of water over 3.6 inches would result in either excess runoff or percolation below the root zone.

Determining the efficiency of an irrigation can only be done accurately by a system evaluation during an irrigation. Depending on the design, maintenance and management of an irrigation system, the efficiency can vary substantially. There are several government agencies and private consultants who can perform these evaluations.

Normal Year Irrigation Schedules

A good planning tool for an irrigation manager is a normal year irrigation schedule. This is an irrigation schedule for a specific field and crop that is based on historical weather data. This schedule can be developed before the irrigation season and can be used to estimate when irrigations will most likely be needed during the season.

A normal year schedule can be updated during the irrigation season using current ETo information. This will result in changes in irrigation dates or amounts that reflect current conditions. For example, lower than normal ETo values would result in either more time before the next irrigation or a smaller amount of required water for the same irrigation date. This updating can be done on paper or by using a computer system.